Chapter 10

Large and Small Scale Hatchery Evaluation

This evaluation of Klamath River basin large and small hatcheries was not required in the Restoration Program evaluation contract, but it was specifically requested of the evaluation team by the KRFWO staff.

Iron Gate Salmon and Steelhead Hatchery and the Trinity River Hatchery are the two large-scale fish culture operations in the Klamath Basin but only Iron Gate Hatchery is reviewed here. Small-scale rearing operations of two types have been operated in the basin: pond rearing programs, using Iron Gate Hatchery chinook juveniles, and hatcheries using native broodstock. The operation of both large and small facilities is evaluated as to whether they met their stated goals in the short and long term and whether the operation is likely to have had adverse impacts on wild fish.

Iron Gate Hatchery

Iron Gate Hatchery was constructed at the time of completion of Iron Gate Dam to mitigate for the loss of habitat blocked by the dam. The hatchery raises fall chinook salmon, coho salmon and steelhead trout. While returns of fall chinook salmon have been robust, coho salmon returns are more erratic and steelhead returns have almost completely disappeared (Rushton, 1997). There is some evidence that operation of Iron Gate Hatchery may have contributed to low escapement in the entire Klamath Basin from 1990 to 1992 (PFMC, 1994) and that is discussed below. Possible relationships between problems with mainstem Klamath River water quality and declines of Iron Gate hatchery steelhead are also explored.

<u>Fall-Run Chinook Salmon</u>

Iron Gate Hatchery returns of fall chinook have ranged from a low of 2,558 in 1981 to 21,711 in 1993 (Figure 10-1). Returns were robust in the late 1980's, very low in 1990-1992 and have since rebounded to near record levels. Returns have always been large enough to prevent problems with loss of gene resources even in very low return years (Waples and Teel, 1990).

Very low returns in the late 1970's, early 1980's and 1991-92 were partially as a result of low escapement rates for Iron Gate Hatchery stocks (PFMC, 1994). For example, the brood years 1979-1987 had an average escapement rate of 24% at Iron Gate Hatchery (12-46%) while at Trinity River Hatchery, escapements averaged 46% (31-69%). For wild fish an escapement rate of 33% is required for population replacement. Iron Gate Hatchery stocks were experiencing higher ocean harvest rates because they matured at four years of age versus age the three maturity characteristic of Trinity River Hatchery stocks (PFMC, 1994). Also in-river Indian fisheries were impacting Klamath River stocks more than Trinity River stocks because of the timing of fishing effort (USFWS, 1992). Other causes for stock declines from 1990-1992 were ocean conditions, drought and increased production of chinook salmon juveniles

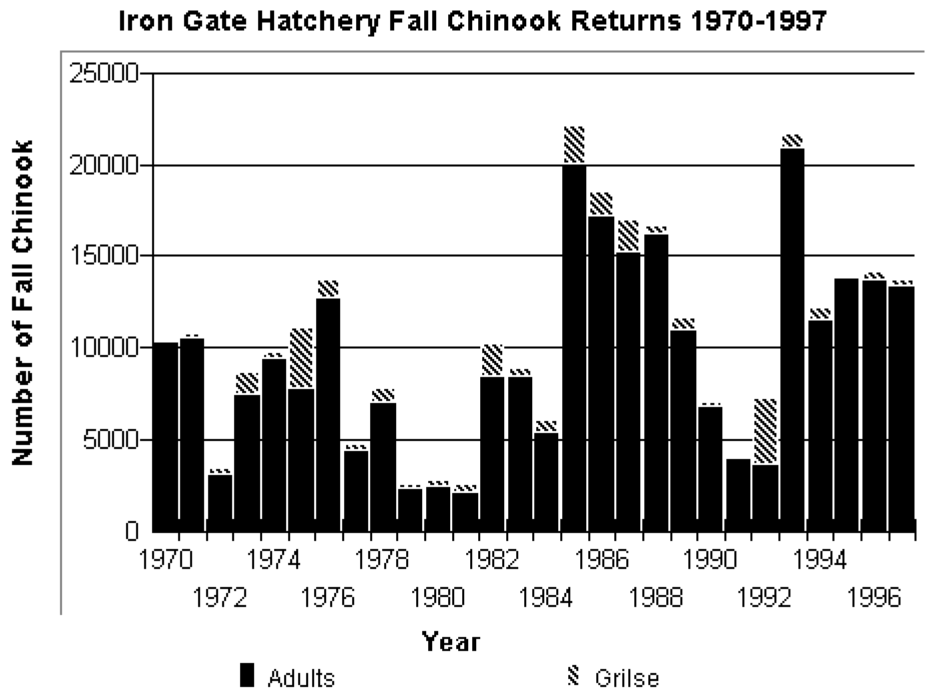

Figure 10-1. Iron Gate Hatchery fall chinook returns from 1970 to 1997.

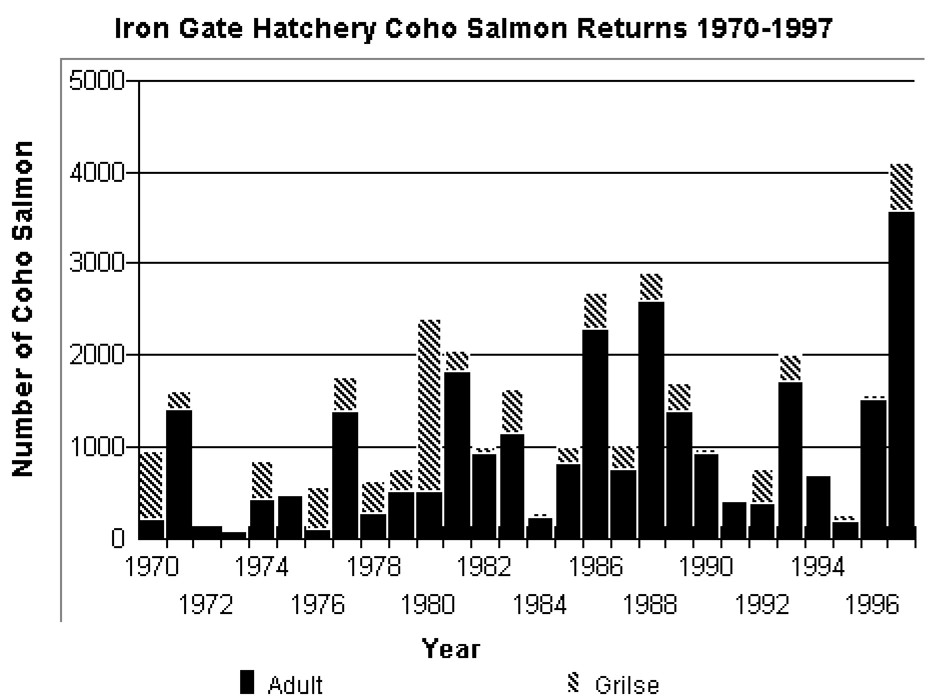

Figure 10-2. Iron Gate Hatchery coho salmon returns from 1970 to 1997. Consistent low returns after establishment of the population may have lead to inbreeding problems.

at the hatchery itself (PFMC, 1994).

Very large returns of fall chinook salmon caused major logistical problems at Iron Gate Hatchery in 1995 and a major problem with over-escapement into Bogus Creek. Large numbers of chinook salmon were released back into the Klamath River and moved back downstream into the Shasta River. Arrangements were made in subsequent years through cooperation with the Humboldt Chapter of the American Fisheries Society (1996) to process surplus Iron Gate Hatchery fall chinook salmon for charitable donations instead of releasing them back into the river. The over-escapement of Iron Gate Hatchery fall chinook in recent years points out the pressing need for universal marking and selective harvest of hatchery fish in all fisheries where feasible.

Coho Salmon

Coho salmon at Iron Gate Hatchery have had variable rates of return since 1970 (Figure 10-2). Low returns in early years and a very high component of grilse were during a period of acclimation of the non-native broodstock (Kier Associates, 1991). Low returns in 1983 could be attributed to El Niño conditions that are particularly hard on coho salmon. The return of only 269 coho in 1995, however, can not be explained by extremely poor ocean conditions. Also fishing pressure was not limiting since no commercial or ocean sport take was allowed in that year. Very low escapement levels could compound problems with loss of genetic diversity of this stock and potential in-breeding depression (Kier Associates, 1991). It is likely that this broodstock will need replacement in the future (within the next 50 years).

Steelhead

Iron Gate Hatchery steelhead have declined to the point where the hatchery run is no longer viable (Figure 10-3). Returns since 1991 have averaged 163 fish with only 12 steelhead returning in 1996 (Rushton, 1997). Scale studies showed that a substantial number of returning fish had not been to the ocean (Jong, 1993; 1994). The increase in resident life history of rainbow trout as opposed to anadromy may be in part owing to water quality problems in the mainstem Klamath River (see Water Quality Problems Impact Hatchery Fish). A new broodstock needs to be acquired for Iron Gate Hatchery, however, without improvements in water quality further downstream in the Klamath River success of re-establishing hatchery steelhead runs may be limited.

Problems Related to Operation

There is some evidence that low returns of hatchery and wild chinook salmon to the Klamath Basin from 1990 to 1992 is partially as a result of increased stocking levels at Iron Gate Hatchery in the preceding brood years (1986-1988) (PFMC, 1994). Record number of chinook fry were reared in those years which resulted in restricted growth in crowded hatchery raceways (PFMC, 1994). Smaller fry migrate more slowly (USFWS, 1994) and survival rates for these brood years were extremely low (PFMC, 1994). The

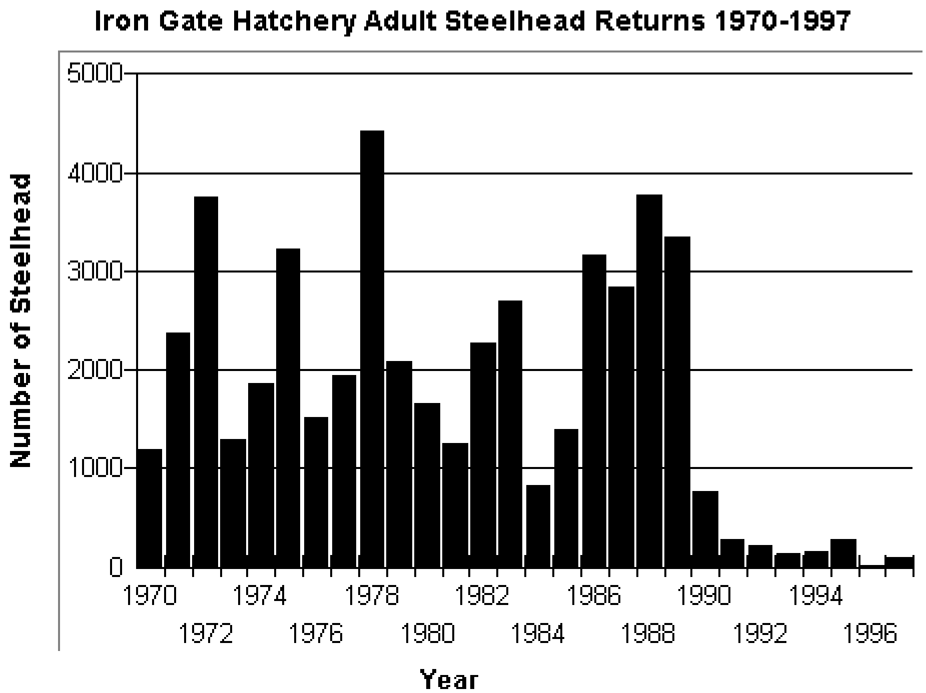

Figure 3. Iron Gate Hatchery steelhead returns from 1970 to 1997.

release of record number of fry also happened to coincide with a sequence of drought years that probably resulted in density dependent mortality of both hatchery and wild chinook salmon fry (PFMC, 1994). The precipitous decline in steelhead returns at Iron Gate Hatchery began in 1990 and continued in successive years. It is possible that density related factors because of chinook over-planting may have had ripple impacts on the success of Iron Gate Hatchery steelhead.

The three chair persons of the Klamath Task Force, Klamath Fisheries Management Council and Trinity Task Force met in the summer of 1992 to review hatchery operations in the basin (CDFG, 1992). They expressed concern with regard to the level of hatchery production and potential impact on wild fish. As a result, egg take at Iron Gate Hatchery was to be decreased from 18,000,000 chinook salmon eggs to 12,000,000. All fry in excess of the 6,000,000 required for mitigation and the 1,000,000 to be held as yearlings were to be exported for use in lake stocking programs or were to be destroyed (CDFG, 1992). The stocking size for chinook salmon fry was also to be a minimum of 90 to the pound at a minimum.

Foote (1995) found dissolved oxygen in Iron Gate Hatchery raceways of 3.9 mg/l, which is in the extreme stress for salmonids. He surmised that "This low value indicates insufficient flow for the biomass within the rearing units." Foote (1995) also found very low fitness values for the released fry with liver glycogen levels of 2.68 mg/100 mg as compared to 8.95 mg/100 mg for Coleman Hatchery fry. While chinook fry in the release group ranged in size from 41-85 mm, no fish smaller than 85 mm was captured at traps downstream. This suggests that survival of fry that are small at release may be quite low. The low fitness of hatchery chinook and poor water quality in the mainstem Klamath River lead to major losses to disease in 1995 (see Water Quality Problems Impact Hatchery Fish).

Although the Three Chairs specified that only 6,000,000 chinook fry be released annually at Iron Gate Hatchery ((CDFG, 1992), the annual report for the 1994-95 (Hiser, 1995) did not mention any transfer of juvenile chinook to other inland programs or of excess fry being destroyed. The low dissolved oxygen found by Foote (1995) does not seem consistent with the release of fewer than 5,000,000 fish and an egg take of approximately11,000,000 described in the hatchery report. The KFMC has also recently discovered that unmarked releases of hatchery fish may not have been reported (Troy Fletcher, personal communication). This may have caused problems with coded-wire tag expansions and lead to problems with harvest management modeling.

Water Quality Problems Impact Hatchery Fish

There is a growing recognition in the fisheries science community that fish disease organisms are omnipresent and that environmental stressors can trigger disease outbreaks (AFS, 1997). Water quality in the mainstem Klamath River falls into acutely stressful ranges for salmonids with regard to temperature and dissolved oxygen (see Mainstem Klamath in Habitat Trends). Foote (1995) found that fish captured at the Big Bar trap on the Klamath River showed a high incidence of Ceratomyxa shasta, a protozoan fish disease. He noted that water temperatures at the trap were in stressful ranges for salmonids. There had been no level of infection of chinook juveniles from C. shasta in raceways at Iron Gate Hatchery from 1992 to 1995 (Foote, 1995) although the disease organism is certainly present since water used by the hatchery comes from Klamath River water. No incidence of disease was found in juvenile chinook captured in a cold water refuge area at the mouth of Red Cap Creek (Foote, 1995). This suggests a linkage between the environmental stress of high temperature and chinook juveniles succumbing to this disease. Poor condition factors of chinook fry from Iron Gate Hatchery may have also decreased immunity. Foote (1995) concluded that a significant portion of the chinook salmon fry release group for 1995 did not survive out-migration because of C. shasta.

The declining success of the Iron Gate Hatchery steelhead program also supports the hypothesis that problems exist with ecosystem function of the mainstem Klamath River. Iron Gate Hatchery has had a precipitous downturn in returning steelhead and a significant percentage of fish returning in some recent years have been residuals or resident rainbow trout that failed to migrate to the ocean and remained in the Klamath River (Jong, 1994). Klamath River releases from Iron Gate Reservoir are moderate in temperature relative to those migrating steelhead might experience further downstream. It is likely that poor mainstem Klamath River water quality could be selecting for the resident as opposed to the anadromous life history of Iron Gate Hatchery steelhead.

Small Scale Hatcheries and Rearing Ponds

Small scale hatchery programs in the Klamath Basin were founded to help reverse the decline of locally adapted endemic populations of salmon in selected Klamath sub-basins. Pond rearing programs had a dual objective supplementing fish for harvest and augmenting spawning returns.

Pond Rearing

Pond rearing programs were founded to supplement the number of chinook salmon available for harvest and to restore chinook runs to selected Klamath sub-basins (Pisano, 1995). The different run timing of Iron Gate Hatchery stock and other differences with locally adapted native populations could confound the latter objective (Kier Associates, 1991). Ponds were stocked with fingerling chinook hatched and reared at Iron Gate Hatchery, which were fed during summer and released in fall to the stream where the pond was located. Funding for pond rearing was provided by grants and contracts acquired by the Northern California Indian Development Council (NCIDC). The Klamath Task Force provided funding for pond rearing in some years. During different periods ponds have been operated on Grider, Beaver, Thompson, Elk, Indian, Bluff and Red Cap Creeks. The ponds began operation in the mid-1980's and were discontinued after 1991. In the most recent years of operation, ponds were operated on Indian, Elk and Bluff Creeks (Pisano, 1995) and funded through NCIDC.

By 1988, a substantial portion of pond reared chinook salmon were being coded wire tagged in order to understand their contribution to fisheries and the success of the pond rearing program. From 1988-1991 over 526,000 pond reared chinook salmon were released, with 379,250 coded wire tagged. Pisano (1995) found that contribution rates to fisheries were 0.26% as compared to a ten-year average of Iron Gate Hatchery yearlings of 2.72%. Downstream migrant trapping showed that in some years, pond reared fish did not move downstream at the rapid rate normally associated with Iron Gate Hatchery yearling releases (PFMC, 1994).

Pisano (1995) indicated that pond program release groups up to 1991 could contribute to returns through 1996 while his report only covered through 1994. Therefore, fall chinook trends in Middle Klamath tributaries such as Bluff, Indian and Elk Creek could have been inflated by pond reared fish through 1996 (see Population Trends). The homing ability of pond reared fish could also be somewhat altered since they were moved during times when they could have been imprinting. Consequently, some of these fish may have strayed to other Middle Klamath tributaries and inflated returns in those sub-basins as well.

Run timing of the vast majority of fall chinook salmon spawning in Red Cap and Bluff Creek is in early to mid-October (Jerry Boberg, personal communication). This contrast with the historic run timing in these basins of November through January (Snyder, 1931 as cited in Kier Associates, 1991). Similar run timing is exhibited by fall chinook returning to Elk Creek and Indian Creek (Bill Beamis, personal communication). High flows during November and December often confound spawning surveys (Jerry Boberg, personal communication) so it is possible that late returning fall chinook are not being counted. The Karuk Camp Creek trapping operation has not noted a major influx of early run fall chinook but that may reflect the smaller basin size and related lower flows in the early season.

Pisano (1995) concluded that:

> "Given the relatively low number of coded wire tags recovered thus far from pond-reared fish, predation problems at the ponds, relatively high maintenance costs, and genetic concerns arising from use of Iron Gate Hatchery fish as broodstock, consideration should be given to permanently discontinuing this program."

Surveys should continue in Middle Klamath tributaries to see if long term benefits are accrued with regard to rebuilding local populations or whether high returns only occurred when pond rearing programs were operated. In drier years when late season spawning surveys are feasible, late run fall chinook salmon returns in Middle Klamath tributaries should be gauged.

Small Scale Hatcheries Using Native Broodstock

Small scale fall chinook salmon hatcheries have been operated in the Lower Klamath and at Camp Creek near Orleans. The Horse Linto rearing project on the lower Trinity River is also discussed because it provides a model both in operation of the facility and its evaluation (Hillemeier and Farro, 1995)

Lower Klamath/Hunter Creek: Between 6,350 and 30,082 juvenile chinook salmon were released by the small scale hatchery operated by Yurok Tribal members on the Lower Klamath from 1986 through 1994 (Lara, 1996). Average output of the hatchery was 14,850 chinook salmon juveniles reared to yearling size. Brood fish were captured with a trigger gill net for several years near the mouth of Blue Creek. Eggs were reared at satellite facilities in early years of operation, such as at Pecwan, but all incubation and rearing in later years was at Spruce Creek. Planting of juveniles was concentrated in Hunter Creek in the latter years of the program.

USFWS (1995) expressed concern over whether broodstock capture by this rearing project might be depleting fall chinook escapement into Blue Creek, which was at a critically low ebb. Gillnet capture in the mainstem Klamath River off the mouth of Blue Creek also posed the potential problem that fish intercepted might be destined for some other location. This is in potential conflict with the objective of the project that was to restore locally adapted Lower Klamath Basin stocks. The rearing project collected brood stock from Hunter Creek using a weir in the latter years of operation. The problem with this method of brood collection was that it risked restricting the gene pool to predominantly fish from the artificial culture operation. This is due to the paucity of natural spawners in Hunter Creek. Interbreeding fish from a restricted family size can lead to problems with fitness and can ultimately harm remnant endemic chinook salmon populations (PWA, 1991). A survey by the Yurok Fisheries Department of Hunter Creek in 1997 found approximately 50 adult chinook salmon of which about half were adipose fin clipped. It is likely that habitat conditions confounded the success of this project (see Habitat Trends).

Camp Creek/Red Cap Creek: The Karuk Tribe and the Northern California Indian Development Council (NCIDC) have operated a small scale hatchery on Camp Creek near Orleans (Jones, 1998). The facility Six Rivers National Forest and the California Department of Fish and Game have been cooperators in the project since its inception. The hatchery has operated since 1986 and uses only native fall chinook salmon broodstock. All juvenile chinook reared by the project are released as yearlings in October, that is after being fed in ponds through summer. Release groups have all been marked, with maxillary clips in early years and with coded wire tags since 1992. The number of fish released has ranged from 4,637 in 1990 to 34,976 in 1995. The total number of juvenile yearling chinook released by the program from 1986 to 1996 was 173,323 or an average of 17,332 per year. The January 1997 floods caused many problems at the facility but eggs and fry were rescued and successfully reared.

Horse Linto Creek: The Horse Linto Creek rearing facility is a cooperative effort of CDFG, USFS and the Pacific Coast Federation of Fishermen's Association (PCFFA). The report produced by Hillemeier and Farro (1995) documented all aspects of operation including brood handling, fish health problems, code-wire tagging and success of varying release strategies. Contributions to fisheries were calculated with assistance from CWT data provided by CDFG. The USFS conducted extensive annual spawning surveys and operated a downstream migrant trap to track juvenile abundance. This allowed evaluation of the success of the operation. The stated objective of the rearing program was to restore natural spawning to Horse Linto Creek. Natural spawning levels in recent years are fully seeding all spawning and rearing areas accessible to chinook salmon. Consequently, the Horse Linto rearing facility has discontinued operation. Six Rivers National Forest is committed to continued surveys to judge the longer term success of these efforts. The reason this project was able to succeed is that Six Rivers National Forest management within the Horse Linto Creek watershed has allowed recovery of ecosystem function. Headwall areas of Horse Linto Creek are undisturbed and logging in steep, unstable inner gorge areas was discontinued after the 1964 flood. The USFS has also stabilized slides to reduce sediment inputs and improved the complexity of rearing habitat through use of in-stream structures.

Straying of Small Scale Hatchery and Pond Reared Fish

Weir operations in the South Fork Trinity River from 1985 to 1995 showed that straying from small scale rearing facilities was significant (PWA, 1994). Coded wire tag returns in the South Fork Trinity included fish from Horse Linto Creek, Hoopa Lower Trinity rearing operations and the Lower Klamath rearing project. Pond reared fish also commonly returned to Iron Gate Hatchery. The wide spread straying of small scale hatchery reared fish could cause problems with genetics and spread of disease (PWA, 1994). No fish from the Camp Creek rearing facility were counted at the South Fork Trinity weir or in Middle Klamath spawner surveys. The use of native stock and the fact that all hatchery juveniles are raised and released in Camp Creek has probably helped this facility avoid straying problems.

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